HMF = Heating Mars Flavour!

It is often stated that honey found in an Egyptian Pharoah's tomb that was over 3,000 years old was still edible. It is not stated what the honey tasted like or whether it was analysed. I doubt that the container had a *Best Before* label!

Honey is at its best soon after sealing in the combs. The process of extracting & processing honey by the beekeeper has an effect on the composition and, therefore, the quality of the finished product. The rate of change is largely dependent on time and, especially, temperature. Heating honey (especially granulated OSR honey) is a common practice & needs to be carefully controlled.

Enzymes secreted by the worker bees' hypopharyngeal glands are added to the nectar they collect. The resulting honey, therefore, contains the enzymes diastase (amylase), invertase & glucose oxidase[1]. Diastase breaks down starch to produce maltose & dextrins, invertase 'inverts' or splits sucrose to glucose & fructose, glucose oxidase oxidizes glucose to gluconic acid & hydrogen peroxide (in the presence of water i.e. 'unripened' honey).

Honey also contains HMF (hydroxymethylfurfural) a substance produced by the chemical breakdown of the sugar fructose in the presence of acids. HMF is present in honey from the early ripening stages in the hive and a small quantity is a natural constituent and contributes to the aroma[1] (new honey contains 1-5 ppm[2]). Although generally believed to be harmless to the consumer, little is known about toxicity[2]. However, Dr Laurie Croft in *Honey and Health* cites evidence suggesting that HMF is harmful to human health – and to bees[3] [2]. HMF is not peculiar to honey and is found in a wide variety of heat processed foods including milk, fruit juices, and spirits[2]. Some jams contain high quantities, perhaps 500 ppm or more[4].

The amount of enzymes decreases when heated e.g. a rise in temperature to 150º F (65.6º C.) for about 3 hours will halve the diastase content[4], 40 minutes at 160º F. (70º C.) will eliminate glucose oxidase[2].

When placed on the market as honey or used in any product intended for human consumption, honey must not except in the case of baker's honey, have any foreign tastes or odours, have begun to ferment or have fermented, ***or have been heated in such a way that the natural enzymes have been either destroyed or significantly inactivated[7].***

Diastase, invertase and HMF levels are regarded as indicators that can show whether honey has been overheated or stored for too long. The EU limits are[1] [7]:

Diastase	>8 ppm.
Invertase	>4 ppm.
HMF	<40 ppm.

The published times taken to increase levels of HMF varies[2,4,5], but all clearly show the higher the temperature the shorter the time needed to raise the HMF level[2.4.5]. For example:

Temp. in ºC.	Temp. in ºF.	Time in days.
30	86	150-250
40	104	20-50
50	122	4.5-9
60	140	1-2.5
70	158	5-14 hours

Table to show the time required to produce 30 ppm of HMF[2]

Dr Riches suggests that if honey is heated to 122º F. (50º C.), it would take nearly 10 days for the HMF content to exceed 40 ppm (and for the diastase level to be halved)[4].

When preparing honey prior to bottling, a temperature of <100º F. (37.7º C.) should be adequate to reduce viscosity & dissolve small crystals without harmful effects. A higher temperature of 122º F. (50º C.) may be needed to liquefy granulated OSR honey, but should not be required for more than 48-72 hours.

In recent years, microwave ovens have been used to liquefy small quantities of granulated honey. Apart from the danger of the honey boiling over (my experience!), treatment with microwaves causes a slight increase in HMF, but an almost total loss of enzymes (period of time not stated)[6].

The consumer can expect a natural & safe product containing beneficial ingredients, which is reinforced by legal requirements. When processing your honey, keep heating to a minimum to maintain the quality of your honey. If possible, try to give advice regarding the storage & display of your honey to avoid unsuitable conditions, which may further alter enzyme & HMF levels.

If you feel that all these rules & regulations are putting you off selling your honey, take comfort from the words of Dr Laurie Croft:

What does all this mean to the honest beekeeper? Is he allowed to heat his honey? From my experience I don't think he need worry too much about it. I have examined hundreds of samples of British honey and very few of them have any HMF in them at all. I think this indicates that the moderate manipulations given to honey in the course of processing by the average beekeeper are perfectly safe[8].

I have always assumed that measurement of HMF was not possible for the average beekeeper. However, it is reported that at the Food Control Department in Amsterdam they have developed a semi-quantitative method to determine the level of glucose oxidase in honey from which can be deduced whether the HMF is below 40 ppm[2]. I must stress that this has been obtained via the web. I have been unable to find further information (9) or verification of the accuracy of the method. I have not yet been able to find a source of the hydrogen peroxide test strips in this country and have not, therefore, analysed any honeys for HMF. It would appear to be a simple test and would give reassurance when selling honey that has been heated. **But further investigation needs to be undertaken to verify the accuracy of the test.** I would be interested to hear from anyone who can provide any technical advice.

Glucose oxidase (hydrogen peroxide/HMF) Determination

Overview of method:

If honey is diluted with water, the glucose oxidase it contains will generate hydrogen peroxide, which can be measured.

Equipment:

Distilled water.

Merckoquant hydrogen peroxide test strips No. 10011*.

Method:

Mix 10 g honey with 40 ml distilled water without warming.

Stand for 1 hour at room temperature (20º C./70º F.).

Immerse test strip for 1 second and after 15 seconds compare it with the colour scale.

Multiply the reading by 5.

This result gives the amount of hydrogen peroxide in micrograms as determined by the glucose oxidase from 1 g honey in 1 hour at 20º C./70º F.

Example: a reading of 2 micrograms of hydrogen peroxide means that 10 micrograms of hydrogen peroxide/gram/hour at 20º C./70º F. is present.

If the glucose oxidase is greater than or equal to 10 micrograms/gram/hour then the HMF is lower than 40 ppm with a 95% reliability.

*Used in the food industry after cleaning machines with hydrogen peroxide.

References.

1. *Bees and Beekeeping* – Eva Crane ISBN 0 434 902713.
2. www.xs4all.nl/~jtemp/hmf.html
3. *Honey and Health* – Laurie Croft ISBN 0-7225-1389-5.

4. *The Effects of Heat on Honey* – Dr HRC Riches.
5. *Encyclopedia of Beekeeping* – Morse & Hooper - ISBN 0 7137 1624 X.
6. *Deutsches Bienen-Journal 3: 78-82 "Honey Quality: the effect of temperature" (1992)* – Werner & Katharina von der Ohe.
7. *Honey (England) Regulations 2003.*
8. *Profitable Beekeeping* – Dr Laurie Croft ISBN 0-946019-02-9.
10. Source.

JD Kerkvliet. Screening method for the determination of peroxide accumulation in honey and relation with HMF content. *Journal of Apicultural Research* 35(3/4): 110-117 (1996) © 1996 *IBRA.*

Hydrogen peroxide strips (Merkoquant test strips No. 10011) available from *VWR International Ltd*., Hunter Boulevard, Magna Park, Lutterworth, Leicestershire, LE17 $XN. Tel.: 01455 558600. Orders: Tel.: 0800 22 33 44. E-mail: uksales@uk.vwr.com. Minimum order: 100 strips cost £31.60 (2007).

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